NASA STTR 2011 Phase I Solicitation

T6.02 Active Debris Removal Technologies

Lead Center: JSC

After more than 50 years of human space activities, orbital debris has become a problem in the near-Earth environment. The total mass of debris in orbit is close to 6000 tons at present. The U.S. Space Surveillance Network is currently tracking more than 22,000 objects larger than about 10 cm. Additional optical and radar data indicate that there are approximately 500,000 debris larger than 1 cm, and more than 100 million debris larger than 1 mm in the environment. Because of the high impact speed between orbiting objects in space, debris as small as 0.2 mm poses realistic threat to Human Space Flight (EVA suit penetration, Shuttle window replacement, etc.) and other critical national space assets.

Recent modeling studies indicate that debris mitigation measures commonly-adopted by the international community will be insufficient to stop the debris population growth in low Earth orbit (LEO, the region below 2000 km altitude). To better preserve the space environment for future generations, active debris removal (ADR) of large and massive upper stages and spacecraft must be considered. The need for ADR is also highlighted in the National Space Policy of the United States of America, released by the White House in June 2010. The Policy explicitly directs NASA and the Department of Defense to "pursue research and development of technology and techniques to mitigate and remove on-orbit debris." Orbital debris is also one of the NASA Grand Challenges outlined by the Office of the Chief Technologist.

An end-to-end ADR operation includes, in general terms, launches; propulsion; guidance, navigation & control; proximity operations; precision tracking; rendezvous; stabilization (of the spinning/tumbling targets); capture/attachment; and deorbit/graveyard maneuvers. Some of the technologies involved in the ADR process do exist, but the difficulty is to make them more cost effective. Other technologies, such as ways to stabilize a large and massive spinning/tumbling upper stage and the capture mechanisms, are new and will require major innovative research and development efforts. In addition, many of the potential ADR targets are upper stages with leftover propellants stored in pressurized containers. Any capture mechanisms of those upper stages will have to be carefully designed to reduce the possibility of explosion.

The focus of this subtopic is to support the development and advancement of cost-effective technologies and techniques to address any of the sub-components described above for active debris removal in LEO. The ultimate goal is to develop the full capability of an end-to-end ADR demonstration in LEO in 5 to 10 years.